

ROADMAP

Rethinking of antimicrobial decision-systems in the management of animal production

Research and Innovation action: H2020 – 817626

Call: H2020-SFS-2018-2

Type of action: Research and Innovation Action (RIA)

Preliminary report on social science theoretical framework

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DELIVERABLE D2.1

Work package N°2

Due date: M12

Dissemination level: Public



About the ROADMAP research project

The overall aim of ROADMAP is to **foster transitions towards prudent use of antimicrobials (AMs) in animal production in different contexts to manage antimicrobial resistance (AMR). Prudent antimicrobial use (AMU) will be achieved by enhancing antimicrobial decision-systems along the food and drug supply chains.** ROADMAP will focus on supporting animal health and welfare through prevention and health promotion actions.

AMR is recognized as a significant threat to global public health and food security. Overuse and improper use of AMs in many parts of the world contribute to the emergence and spread of AMR. Although human and animal health require AMs, it has been estimated that two thirds of the future AMU growth worldwide will be in animal production. Improving the management of AMU in farm animals is therefore a critical component of dealing with AMR and optimizing production in the livestock sector. Nevertheless, the variety of contexts of AMU in the livestock sector is a major challenge to managing AMR. **There is no “one-size-fits-all” solution to improve AMU and strategies must be contextually developed** (for instance, strategies used in the Danish pig industry would be difficult to adapt and adopt in French free-range poultry farming). Successful solutions must be combined and tailored to the production systems and the social and economic context in which they operate.

ROADMAP will meet three general objectives, in line with the EU AMR Action plan: i) **Rethink AM decision-systems and animal health management**; ii) **Develop options for encouraging prudent AMU in animal production**; iii) **Engage all actors in the food and drug supply chains in fostering a more prudent use of AMs.**



Project consortium

Part. N°	Participant organisation name (acronym)	Country
1	Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (INRAE) **	France
2	Association de coordination technique agricole (ACTA) ***	France
3	Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) **	France
4	University of Liverpool (ULIV) *	United Kingdom
5	Cardiff University (CU) *	United Kingdom
6	James Hutton Institute (HUT) **	United Kingdom
7	Alma Mater Studiorum - Università di Bologna (UNIBO) *	Italy
8	Aarhus Universitet (AU) *	Denmark
9	Eigen Vermogen van het Instituut voor Landbouw en Visserijonderzoek (EV-ILVO) **	Belgium
10	Research Institute of Organic Agriculture (FiBL) **	Switzerland
11	Stichting Wageningen Research (WR) *	Netherlands
12	Swedish University of Agricultural Sciences (SLU) *	Sweden
13	Southern Agriculture and Horticulture Organization (ZLTO) ***	Netherlands
14	European Forum of Farm Animal Breeders (EFFAB) ****	Netherlands
15	Fundacion Empresa Universidad Gallega (FEUGA) ****	Spain
16	Dierengezondheidszorg Vlaanderen (DGZ) ***	Belgium
17	INRAE Transfert (IT) ****	France

* Universities/veterinary schools

** Research institutes specialized in both fundamental and applied agricultural and veterinary sciences

*** Public and private advisory services Organisations

**** Knowledge transfer and Innovation organisations



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List of acronyms and abbreviations

AMR – Antimicrobial resistance

AMU – Antimicrobial use

ANT – Actor Network Theory

STS – Science and Technology Studies

WP – Work Package



1.0 Summary

This report presents an overview of the conceptual approaches underpinning work package 2 (WP2) of the ROADMAP project. ROADMAP focuses on antimicrobial resistance and the use of antimicrobials in different animal farming systems. Work package 2 is the work package which focuses on practices and processes at the farm level. The theoretical framework is organised into a cascade of concepts, which seek to conceptualise the major change processes which need to occur on farm in order for antimicrobial use (AMU) to be reduced. The overarching approach is Sutherland et al.'s (2012) 'triggering change model', which identifies trigger points for major changes in farming practices. This model posits that farms are largely path dependent, reflecting 'sunk costs' of land, infrastructure, and knowledge, as well as established patterns of knowledge seeking and professional identity development. When major changes in farming trajectory occur, these are primarily in response to trigger events – major events or phenomena (such as retirement of a farmer or integration of a farm successor, a major disease outbreak, and prolonged unprofitability of the farming operation). These events lead farmers to actively reconsider their practices and evaluate new options. If a viable option is found and proven successful, it becomes part of the new path dependency.

Path dependencies are thus both social and structural. To further consider these issues, the theoretical framework embeds concepts of 'good farming', which consider how farmers' role performances and associated symbols influence farming practices. The research is also informed by the multi-level perspective, which consider the role of actors outside of the farm – such as processors, suppliers, supermarkets, government bodies, as well as governance arrangements (e.g. markets, regulatory context) in influencing AMU. Particularly for intensive, vertically integrated farming operations, decisions about AMU may largely be decided outside the farm level. WP2 focuses at farm level, but integrates these concepts the multi-level perspective to ensure that these issues are recognised. Supply chains are addressed specifically in WP1 and WP5.

The empirical research in WP2 is also expected to benefit from the integration of a range of other concepts which are useful for understanding AMU and placing empirical findings within recent literature on animal human relations more broadly. These approaches include biosecurity studies, risk society, science and technology studies, social practice theory, and care and more-than-human approaches. Not all of these approaches are theories as such, or are necessarily unified fields of enquiry. Some should instead be regarded as focal lenses homing in on particular topics and aspects. We do not here attempt to combine these different approaches into one coherent approach or to create yet another, new approach. Instead, we seek to highlight how the different approaches can help to bring attention to different aspects of antimicrobial use and resistance.

The theoretical framework directly influences the methodological approach adopted in the workpackage. The theoretical framework concludes with an overview of the methods undertaken in WP2, to inform surveys and qualitative interviews with veterinarians, farmers and farm employees. These comprise typology development, narrative inquiry and discourse analysis.



2.0 Introduction

The ROADMAP project is far from the first project which has attempted to understand and grapple with issues of antimicrobial use (AMU) and resistance (AMR) in relation to livestock farming. While many such projects have focused on aspects of microbiology and epidemiology as well as individual behaviour, ROADMAP contains a strong social science component. As such, it is based on the premise that AMU and change need to be understood as social practices influenced not only by biophysical, economic and individual psychological factors, but also multi-level political, material and social systems and processes involving multiple actors.

The project is structured as a number of work packages (WPs) which concentrate on different aspects of AMU. Though guided by a shared framework, each work package team develops a more detailed theoretical framework to guide their specific approach. This report deals with the approach taken in the second work package (WP2) which focuses on the farm level interactions between farmers, farm workers, advisors, veterinarians and other humans, as well as with more-than-human actants such as the animals, microbes and pharmaceuticals. The wider societal, political and economic contexts, and influence of other actors such as retailers and policy makers are still present and taken into account in WP2, but as seen and experienced from the perspective of the farm level. This report describes how the ROADMAP team conceptualises and approaches the tasks in WP2 as well as the links to other work packages.

The approach taken in WP2 is characterised by the use of mixed methods and by drawing on literature from the social sciences, particularly agricultural sociology and cultural geography. Though a relatively recent topic in the social sciences, use of antimicrobials in farming has been described, investigated and conceptualised in a variety of ways from both natural and social science perspectives. Often, the focus has been on the behaviour of the individual farmer (or veterinarian) though other studies have focused either on political aspects and or taken a closer look at the science of antimicrobial resistance and how scientific facts about antimicrobials are produced (see Chandler et al., 2016a for an overview of social science studies on AMR).

The theoretical framework for WP2 is outlined in Figure 1. Given the focus of WP2 on the farm level, the theoretical framework focuses on those approaches that seem particularly relevant and promising for understanding practices and changes at this level while recognising other approaches that would be more relevant to other aspects of AMU and AMR. However, it has been important for ROADMAP to move beyond behaviouristic approaches with their focus on the individual and on psychological factors. We therefore undertook a review of the literature and of different approaches that could help us shed new light on AMU and AMR at the farm level. We identified three particularly promising approaches: the triggering change model, notions of what it is to be a 'good farmer', and the multi-level perspective on systemic change. Together these approaches represent the key concepts explored in WP2. We situate these within broader literatures which specifically relate to animal human relations, identifying these as potential analytical lenses through which the empirical findings can be understood. These include biosecurity studies, risk society, science and technology studies, social practice theory, supply chain analysis, and care and more-than-human approaches. The theoretical framework has directly informed the research methods: discourse analysis, narrative approaches and farmer typology development, which are described briefly in the final section.

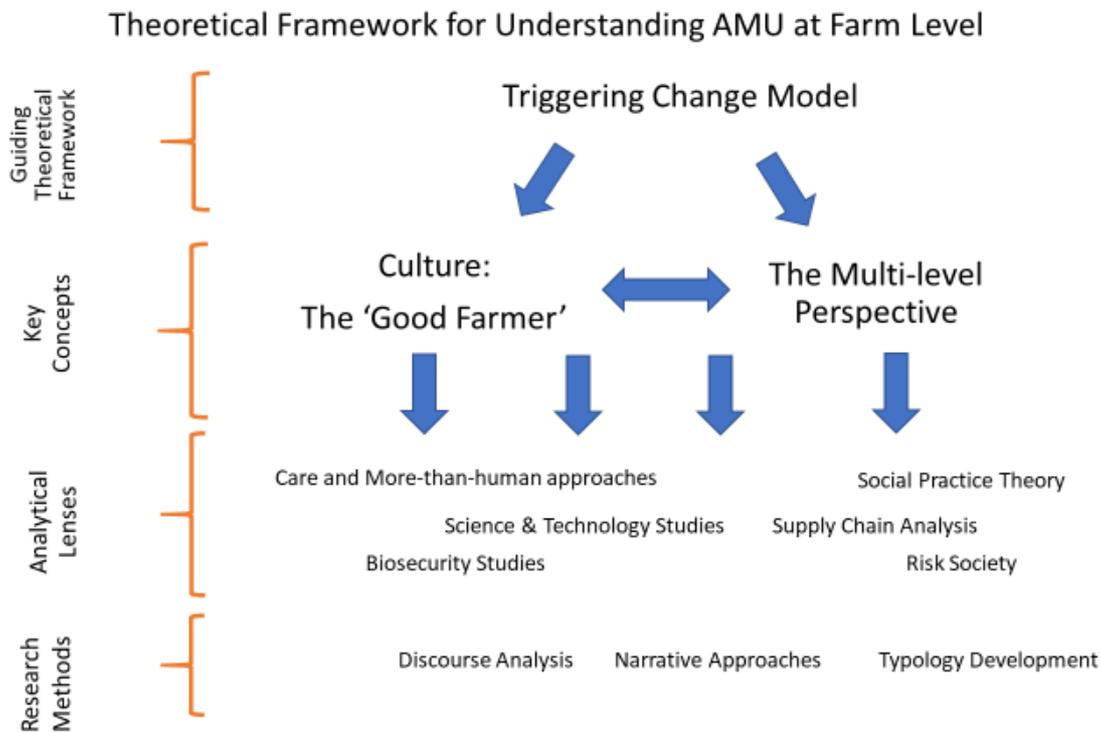


Figure 1: WP2 Preliminary Theoretical Framework

The following sections provide very brief presentations of some of these approaches and how we understand their relevance for the work of WP2 in RoadMap. The sections are written to be stand-alone, basic ‘primers’ on the particular approaches. Each concludes with a brief ‘application to ROADMAP’ section, explaining the strengths and weaknesses of the concept in particular relation to RoadMap objectives.

This report is written as part of the ongoing work of the ROADMAP project and should as such be regarded as work in progress that will develop further as data is collected and the project team’s understanding deepens. The aim of this report is therefore also not to come up with a unified theoretical approach (whether a completely novel approach or by choosing one theory above others from those presented below) but to select those approaches and theories which enhance understandings of particular aspects of AMU. We believe that different approaches have various strengths and weaknesses which help bring these aspects into focus, while also having specific ‘blind spots’ of issues and angles that are not addressed. In the following sections we look at these strengths and weaknesses and the implications they have for understandings of AMU. We here follow Sovacool & Hess (2017) in allowing different approaches to sit uneasily alongside each other and explore where they lead. In the last section, we explain how some of these approaches are feeding into the data collection and analysis in the ROADMAP project. At the end of the project a final report on the approach taken will be produced and be made publicly available.



3.0 Guiding Theoretical Framework – the Triggering Change Model

It is well established in the academic literature that farm businesses tend to be path dependent, following a steady trajectory (Wilson, 2007; Chhetri et al., 2010; Sutherland et al., 2012). Contemporary farms have considerable ‘sunk costs’ – in terms of infrastructure, equipment and in many cases live-stock - all of which would require substantial reinvestment and time to replace. Commodity production is also limited by the productive capability of the farm’s land and access to markets. Farmers expect commodity market fluctuations and have learned not to respond immediately (Sutherland et al. 2012); the prudent response is often to wait for market conditions to return to ‘normal’ rather than to make major changes to management practices. To respond to an increase in milk prices, for example, could require investment in additional cattle, housing and labour, which may not be readily available; by the time these investments were made the milk price may have decreased.

Farmers also have particular skillsets which have typically developed over decades, as well as professional role identities and competencies grounded in the commodities they have traditionally produced (the ‘good farming’ ideals further described in section 4). Farmers tend to interact with the same sources of information and advice (e.g. visiting agricultural marketplaces, meeting advisers, going to agricultural training events) which will reinforce current trajectories (Slee et al., 2006). Those sources of advice have developed expertise on particular topic areas; Padel (2001) and Ingram (2010) have observed reluctance of both farmers and the extension community to engage in new systems of agriculture such as organic farming and minimum tillage, which need new forms of knowledge. Farmers may therefore appear resistant to change. These path dependencies may also lead to inefficiencies, when suboptimal configurations of technologies, expertise and become embedded in farming practice (Arthur, 1994). Of particular relevance to RoadMap, these path dependencies embed AMU in farming practices, making them difficult to change.

Recent literature demonstrated the importance of ‘tipping points’ or ‘triggers’ for overcoming path dependencies. The socio-ecological systems, literature, for instance, has demonstrated how these systems are similarly subject to inertia which can be overcome by extreme events, leading to a new stable (or inert) system (Holling and Gunderson 2002). The multi-level perspective (Geels, 2004, 2005; Kemp et al., 2007; Rotmans and Loorbach, 2009), described further in section 4, aims to understand how major changes occur in socio-technological systems, assessing how ‘niche’ innovations become mainstream through regime change. For RoadMap, we utilise a conceptualisation grounded in social psychology: the triggering change model.

The triggering change model was developed by Sutherland et. al (2012) from a set of empirical studies with UK farmers. They observed a broad pattern to major changes in farming trajectories, particularly in relation to conversion to organic farming. These major changes were preceded by ‘trigger events’ – typically multiple events which destabilised the farming trajectory, leading to a period of active re-consideration of farming practices which may or may not lead to durable changes in the farming trajectory. These trigger events included farm succession, prolonged commodity price declines and major disease outbreaks (e.g. foot and mouth disease). The farmers in their studies reported experiencing these triggers, which led them to reassess their farming practices and seek solutions. These solutions involve considerable new investments (e.g. in technologies, professional competencies) and were therefore fragile when first implemented. It took time for these new approaches to become embedded in the farming system. In some cases, the approaches were unsuccessful – for example, not resulting in the increasing yields or profits anticipated, or conflicting too strongly with farmer identity (conversion to organic farming, for example, can involve accepting that fields will have a number of weeds, which can be problematic if a farmer has prided himself on weed-free fields). These farmers therefore



returned to the active assessment phase to consider other possibilities. In some cases, the farmers returned to the original path dependency (e.g. because the milk price returned to previous levels). In the specific case described in the Sutherland et al. paper, the sudden influx of converts to organic farming following the introduction of conversion subsidies led to over production of organic milk. Farmers who had ‘stayed the course’ with conventional milk production throughout the downturn in production reinforced the economic rationality of this choice. The stages of the Triggering Change Model are presented in Figure 2.

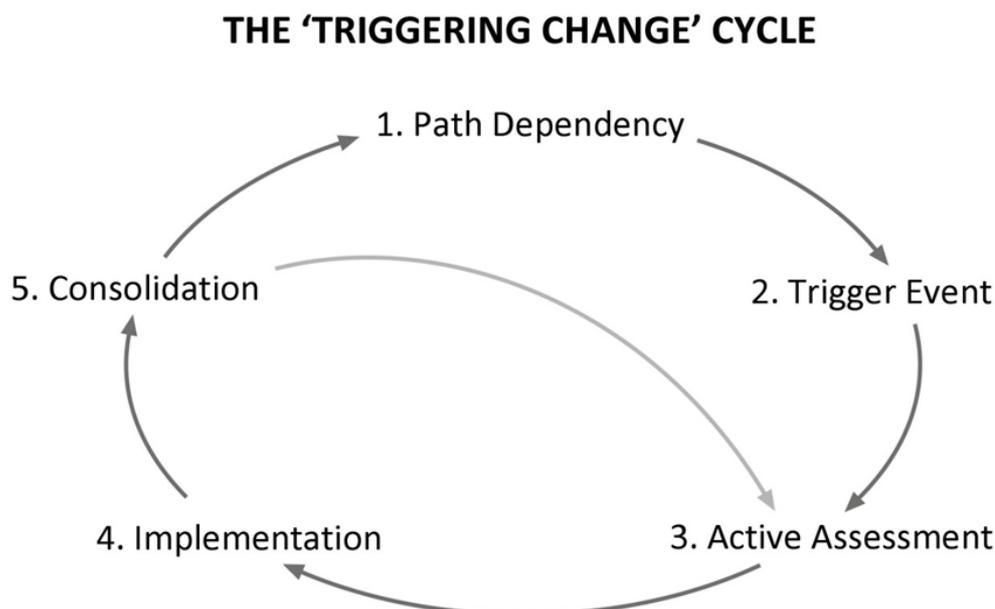


Figure 2: The Triggering Change Cycle (Sutherland et al. 2012)

The triggering change model is grounded in social psychology. Social psychology draws attention to the interplay of social interactions (particularly social norms) and decision making. Ajzen’s (2005, 2011) Theory of Planned Behaviour, for example, draws attention to social norms and practical limitations, in addition to the attitudes or values associated with the objective of the decision-itself (see Sutherland 2010, 2011 for applied examples). As can be implied by its title, the Theory of Planned Behaviour emphasises the planning involved in making a major decisions or changes. Petty and Cacioppo’s (1986) Elaboration Likelihood Model similarly emphasises that major changes involve what they term ‘active route processing’ – active consideration of the options and their implications prior to making a change. They contrast this approach to decision-making with ‘peripheral route processing’ – decisions which are given little active consideration, and are often influenced by peers or influential others. These latter changes tend to be incremental and less durable. In relation to AMU, active route processing is involved in design of new facilities, employment of new staff and contracting with new processors. Peripheral route processing is involved in following simple veterinarian recommendations or minor changes to withdrawal periods before selling livestock.

Critique: The triggering change model enables identification of particular points in time where AMU is likely to change. It shifts the focus away from AMU specifically, to consider the broader trajectory of the farm and how it is influenced. AMU may be more impacted upon by the decision to employ less skilled labour or intensify production through new facilities, than an active decision about AMU per se. The weakness of the triggering change model is that it focuses at the level of the farmer, potentially over emphasising the room for manoeuvre that farmers have in a particular situation. Many of the



decisions made on farms are heavily influenced by external structures, particularly procurement standards.

4.0 Key Concepts

To better understand the path dependencies, triggers and change processes involved in AMU, we draw on three further conceptual approaches. The multi-level perspective draws particular attention to the range of actors outside of the farm who influence on-farm practices. In contrast, the ‘good farmer’ approach enables us to delve further into the social construction of farming practices, and how farmers’ identity as ‘good farmers’ shapes how they treat and care for their animals.

4.1 Multi-level Perspectives on Transitions

Similar to Supply Chain Analysis, transition theories and studies look at the wider context though here the focus is on innovation and change rather than on analysing the status quo of an existing system. Transition theories encompass a variety of approaches used to study how socio-technical transitions happen, and to some degree how these transitions can be shaped or made to happen. The focus is often on new technologies, and on the factors that enable or hinder their spread. In the context of ROADMAP, we have concentrated on the Multi-Level Perspective (MLP) on transitions (see e.g., Geels and Schot, 2007) as this approach is useful in linking processes at different levels from the micro to the macro. In this approach transitions are understood as the outcome of interactions of events or processes between different levels. These consist of niches, socio-technical regimes and socio-technical landscapes.

Niches constitute the lowest level (the micro-level) in the MLP and consist of small networks and individuals. It is at this level that innovations are understood to happen. In the context of antimicrobials this could, for example, be a pharmaceutical lab/researcher, veterinary practice or small group of farmers who develop new antimicrobial substances or ways of dealing with animal diseases or ensuring animal health. The next higher level is the sociotechnical regime which represents the existing system with its organizational networks, material aspects, institutional actors, rules and values. This could, for example, be existing pharmaceutical companies, retailers, agricultural advisory systems, legislation and policy. While some of these elements are thus the same or similar to those which would be included in a Supply Chain Analysis the sociotechnical regime is conceived as broader and includes additional elements and organisations and the focus is on how this level interacts with both the higher and lower levels. The sociotechnical regime is seen as relatively stable. Changes are therefore most likely if the sociotechnical regime is somehow disrupted. Such disruptions can, for example, come from the socio-technical landscape, which constitutes the highest level in the MLP. The socio-technical landscape thus constitutes the macro-level and is seen to be largely outside the influence of niches and regimes. The sociotechnical landscape comprises natural, political and social elements. Events at the landscape level could, for example, be changes in markets or disease outbreaks which can disrupt sociotechnical regimes and thereby open up opportunities for niches and their innovations. The recent Covid-19 pandemic has powerfully demonstrated this as it has forced many businesses including farmers and veterinarians to adapt processes and products to deal with disruptions in supplies, work and transport routines.

While the success or failure of innovations is seen to depend in part on their inherent qualities (i.e. their superiority or inferiority to other technologies), it is also seen to depend on events at the levels of sociotechnical regime and landscape. Success or failure thus mainly becomes a question of alignment between developments at the level of the niche and events at the other levels. Creating supportive niches may thus not be enough to ensure the success of innovations. These may, instead depend



on events at the regime and landscape level to provide opportunities for innovations to spread and become established and ultimately integrated into the sociotechnical regime (e.g. as new product on the market or a new organisational structure). Despite its emphasis on increasing stability and resistance to change going from the niche to the regime and landscape level, the MLP does not posit a one-way interaction or pathway. Instead, it is recognised that there can be different transition pathways which can lead to the successful establishment of innovations under different circumstances (Geels and Schot, 2007, Sovacool and Hess, 2017).

Application to ROADMAP: In the context of ROADMAP, the MLP can help to understand what conditions might enable or hinder not just the development of novel approaches to AMR but for these to become established and integrated into higher levels (e.g. in the form of supply chains and policy). It can thereby help us get away from a simplistic focus on changing farmers' (or veterinarians) behaviours in the face of existing legislation, market structures and norms. Criticism of the multi-level perspective includes its focus on single regimes and on innovations which makes it less helpful in understanding changes in everyday practices which often cut across different domains (Hargreaves et al., 2011). Recent applications to farming systems suggest that it is more helpful for understanding technological transitions (e.g. new farm machinery) than environmental or social transitions (Sutherland et al. 2016).

4.2 The Good Farmer

While the ROADMAP project is seeking to go beyond the focus on individual norms, values and behaviours, it is still relevant to look at the way in which notions such as what it means to be a good farmer how this can be relevant to AMU. The 'good farmer' concept explores the standards and socialised norms farmers hold themselves and their peers up to and how this influences their practices. This is similar to elements of meanings associated with particular practices as seen through the lens of Social Practice Theory. Assessments of 'good farming' commonly draw on Bourdieu's concepts of capital (Burton et al., 2008; Butler & Holloway, 2015; Haggerty et al., 2009; Sutherland, 2013; Sutherland & Darnhofer, 2012). Bourdieu's work explores power dynamics within society and how power and social order are reproduced and transformed (Bourdieu, 1984). According to Bourdieu (1986) capital is accumulated through labour and comes in the form of economic capital – material and financial property; social capital – networks of connection with other people; and cultural capital – signs of prestige and status. Cultural capital can exist in different forms: in institutionalised form such as educational qualifications, in objectified form of high status goods, and in embodied form in skills and mental dispositions acquired over time which are visible to others (Bourdieu, 1986). Critically, these types of capital are exchangeable to various degrees – economic capital can be exchanged for cultural or social capital (e.g. utilised to develop skills or gain access to particular social groups), although this exchange may not be immediate or direct. Capital acts as a conservative force in the world; capital has the potential to produce profits and to reproduce itself, meaning that not all outcomes are equally likely in the social world – those with capital are likely to produce more capital, those without must invest more labour to produce capital (Bourdieu, 1986).

Using Bourdieu's theory, farmers will strive to be good farmers through accumulating different kinds of capital within the field of agriculture (Sutherland and Darnhofer, 2012). Much of the early good farming literature argued that farmers are resistant to change – that cultural capital ensures that things stay the same, because farmers get both economic and cultural value out of performing actions which are symbolic of being a good farmer (e.g. Burton, 2004; Burton et al., 2008). More recent literature has argued that good farming standards can and do change, but it takes time. The cultural capital inherent in good farming leads to a degree of inertia, but when farmers are challenged in some way (particularly



if practices are no longer profitable), then farmers will change their activities and renegotiate associated good farming standards (Sutherland, 2013; Sutherland and Darnhofer, 2012). In addition, farms within different geographic regions, agricultural sectors and production markets such as organic and conventional have been shown to have different ideals of good farming (Sutherland, 2013). Previous studies have shown how good farming is associated with economic capital in the form of agricultural machinery and equipment (Butler & Holloway, 2015); social capital in the form of social ties and mutual obligations between farmers (Flanigan & Sutherland, 2016; Sutherland & Burton, 2011), cultural capital in the form of prestigious skills, knowledge, experience and symbols of good farming such as a tidy fields and well-kept live-stock (Burton, 2004; Butler & Holloway, 2015; Haggerty et al., 2009; Naylor et al., 2016; Sutherland, 2013) and farmers' agricultural pedigree and connection to a farming family (Burton, 2004).

A small number of studies have used the good farming concept in relation to animal health. These studies have shown that good farming is exemplified through the cultural capital embodied in stock keeping skills: having the skills to assess the health and welfare of an animal by eye (Naylor et al., 2016; Burton, 2008; Butler & Holloway, 2015; Haggerty et al., 2009, Shortall et al., 2018). Good farming is also exemplified in the objectified cultural capital in healthy and profitable animals (Wilkie, 2005; Naylor, 2016), and high standards of animal welfare (Haggerty et al., 2009). The condition of a farmer's livestock can be 'read' by other farmers through visual signs of health and vitality such as a shiny coat, bright eyes and alertness and energy in movement to assess the farmer's level of skill as a stock keeper (Burton et al., 2008). Naylor et al. (2016) carried out a study on good farming in relation to exotic diseases and identify three good farmer ideals: stock keeping skills and care for the animals; being a good neighbour and not causing biosecurity problems for the sector – in terms of buying and selling animals with care and culling animals when they pose a risk to other farmers; and the good public facing farmer who has a reputation for biosecurity.

Wilkie (2005) argues that the role and importance of the stock keeper has changed with the industrialisation and intensification of agriculture; larger herd sizes mean that farmers may not be able to get to know their animals individually. The result is a change from "husbandry to industry" (Wilkie, 2005 p.216). This change has been highlighted in recent literature on mechanisation: Butler & Holloway (2015) showed how adopting automatic milking systems could change the farmer's understanding of good farming, with practices of judging animals by eye being partly or wholly replaced with the use of data to monitor health and wellbeing. Naylor et al. (2016) found understandings of good farming divided along the same lines in different sectors. In poultry and pig systems good farming consists of monitoring certain key performance indicators such as mortality rates and water intake, whereas in the cattle and sheep sectors good farming was identified as tacit skills and knowledge that allowed farmers to assess health and welfare by eye. Hansen (2014) shows how mechanised dairy production systems mean that workers need not have skill or experience working with animals. Haggerty et al. (2009) also found tensions within the notion of good farming in pastoral sheep production in New Zealand, with progressive ideas of intensifying production through increasing stocking density conflicting with some farmers' traditional views of caring for sheep to ensure their health and welfare. Shortall et al. (2018) found two conflicting 'good farmer' identities among vets and farmers interviewed: the large, commercial farmer who has the economic capital to invest in biosecurity and veterinary services; and the self-sufficient stock keeper whose cultural and social capital lead them to manage herd health independently.

Application to ROADMAP: The good farmer concepts identifies healthy livestock animals as an important symbol in farmers' identity. Farmers seek to produce this symbol through a variety of means, which can be expected to include antimicrobial use. Farmers may resist alternative forms of treatment



which are seen to be less effective, or to cause the animal additional suffering. The critique of the good farmer approach is linked to that of Bourdieu's approaches more broadly – that they are better suited to explaining maintenance of the status quo than to understanding change processes.

5.0 Further analytical lenses

In this section we present further bodies of literature which will inform the data analysis. ROADMAP research is situated within a broader academic context of biosecurity studies, the risk society, science and technology studies, value chain analysis, social practice theory and the recent 'more-than-human' turn in social research. These are summarised in turn.

5.1 Biosecurity Studies

'Biosecurity' refers both to policies and practices relating to the governance of biological risks, as well as their critical study. Broadly speaking, it describes political techniques and strategies aiming to manage and control 'unruly biological matter', whether microbes and viruses or invasive plants and animals (Barker et al., 2013). Of particular interest to ROADMAP are the interventions and monitoring practices which aim to regulate 'pathological lives' in the context of food production systems (Hinchliffe et al., 2016). Within the natural sciences, these have often been considered through a biological and epidemiological lens which focuses on disease transmission and its prevention. Practices informed by such a focus may be framed as a universal good, with associated research aiming to find out how to inform farmers and motivate them to carry out better biosecurity (Donaldson, 2013). In contrast, social science research has sought to foreground the political and social aspects of biosecurity practices, its different governance regimes and ontological politics. This work has increasingly highlighted how contemporary forms of biosecurity are complex and transient assemblages of knowledges, techniques, institutions and practices (Braun, 2013; Hinchliffe et al., 2016; Law, 2006). Moreover, they also emphasise how policy and regulatory protocols are contingent and contested by different actors and their practices (Enticott, 2008; Enticott et al., 2014; Law, 2006). Critical literature on biosecurity, therefore, can help improve understandings of the tensions between the macro- and micro-systems, interactions and decisions involved in AMU policy and animal health care practices at a farm-level.

There are several key aspects commonly highlighted by critical biosecurity literature. Firstly, that its enactment and understanding has historically centred on various spatial and moral boundary-making and bordering practices. These might include the territorialisation of agricultural spaces and sites, or else the bodies of animals, viruses and bacteria (Enticott, 2008; Hinchliffe et al., 2013; Hinchliffe et al., 2016). '[T]o separate diseased from healthy life' (Hinchliffe et al., 2013), disease spread through farm animals and their spaces has often been regulated through a variety of interventions. For example, practices improving sanitation and hygiene; segregating healthy and un-healthy animals; or through culling ill or undesirable animals (Barker et al., 2013; Hinchliffe et al., 2013; Law, 2008). However, these studies have also shown that governing through such 'border-lines' is problematic, in part, because the world (and human economies) requires the circulation of multiple forms of life to survive, thus rendering absolute separation neither possible nor desirable (Barker, 2015; Hinchliffe et al., 2013). Understanding the topological spaces of microscopic, viral life- as in the case of AMR- thus challenges the effectiveness of such an approach to managing animal health.

A second element relates to this interconnectedness and the possibility that viruses and bacteria can unexpectedly emerge within different places, animals and assemblages. Therefore, biosecurity interventions have been shown to target both 'present' and 'potentially present' pathological threats



(Braun, 2013; Hinchliffe et al., 2016). Policy and practices, therefore, are not merely enacted in response to disease events, but also in anticipation of these through logics of ‘pre-emption’ and ‘preparedness’ (Hinchliffe and Bingham, 2008; Braun, 2013). Through preparedness, governing regimes plan for what comes after inevitable events by producing logistical protocols and practices that order lives, things and information to maintain economic and biological systems and networks. However, such interventions require ethical judgements by practitioners and are bound up in complex material and moral politics.

Relatedly, work from the social sciences has highlighted how biosecurity, in practice, is not smoothly enacted, but contingent on a variety of human and nonhuman factors. Firstly, official protocols and frames of disease might be contested and diversely understood by actors, such as farmers, whose own situated, ‘proximate’ knowledges and experiences contrast with these (Enticott 2008; Maye et al., 2014). In other words, decision-makers can frequently overlook the culturally-rooted belief systems that co-constitute alternative conceptions of risk, health and disease (Enticott 2008). Furthermore, this also relates to wider tensions of (dis)trust between practitioners and authorities (Enticott et al., 2014). Under such conditions, valid questions have been asked about which and whose knowledges are deemed most important, the ways in which these are included or excluded from decision-making, and whom particular outcomes are mostly likely to benefit (Enticott and Wilkinson, 2013). Critically, research has also shown that the success of biosecurity regimes is often dependent on the inclusion of tacit and experiential knowledges to help generate more resilient and comprehensive ecologies, as in the case of avian flu (Hinchliffe and Lavau, 2013). Indeed, it is through such knowledge ecologies that practices and systems are better able to adapt to the unexpected, place-specific interactions, ‘interferences’ and realities that challenge the objectives of regulation (Hinchliffe and Bingham, 2008).

Application to ROADMAP: Considering AMU and AMR through the lens of biosecurity can help direct attention to the ways in which animal health, its management and associated risks are understood and framed by different actors, whether farmers, farm workers, farm animals, vets, consumers, society, etc. Biosecurity literature’s focus on differing knowledges and the spatialities, temporalities and materialities of illness, disease and intervention, can further understandings of the ways in which AMR, AMU and its reduction are conceived at the farm-level, and in relation to wider systems.

5.2 Risk Society

While Biosecurity Studies look at the way in which risks associated with animal diseases are perceived and dealt with at the farm as well as other levels, Beck’s seminal work ‘The Risk Society’ (Beck, 1992) is a sociological account of the wider social world through the lens of risk. The theory contends that society has reached a stage of socio-technical development, defined as second modernity, or late industrial society, in which anthropocentric risk is one of its primary characteristics: the risks that characterise the modern world are of our own making. Technological development has brought, alongside clear benefits, a host of risks including new nuclear horizons, genetic possibilities and uncertainties, and an existential crisis fixed upon manmade environmental degradation. The Risk Society reveals socio-technical ambiguities and paradoxes. Whereas scientific and technological domains were commonly framed as providing solutions and progressive improvements to problems centring on human needs and condition, now, in second modernity, promising advances are inextricably fused with uncertainties threatening the greatest calamities (Beck, 2009). In lockstep with such paradoxes, science is argued to have lost its authority amidst raging social conflicts about the very definition of risks. The Risk Society identifies major changing societal patterns underlying the proliferation of risk, including a



‘de-traditionalisation’ of practices; a corresponding ‘individualisation’ of human action with actors increasingly cut off from former ties of class, kin, community and shared practise; and a globalisation of technology, science and society which magnifies risk.

Risk Society analyses generally focus on risk at the macro level, typically investigating the social and institutional arrangements in which they are contested and negotiated (Giddens, 1998). A political dimension is explored whereby new forums and configurations of power are critically evaluated in regards to their capacity to enable change (Beck, 2016). However, the theory does consider both practice and change and, therefore, can be usefully applied at the farm level to support other approaches.

Application to ROADMAP: It is straightforward to conceptualise the issue of AMU and AMR as amongst the paradoxes that the risk society illuminates: scientific advances that on the one hand offer medicinal benefits across a myriad of health conditions, including life threatening illnesses that are treated at an economically affordable and global scale, on the other hand, have created dependencies and resistance that represent an alarming risk. “Even if new medicines are developed”, the World Health Organization fears these “will remain a major threat”. This has resulted in a clear sense of the problem appearing beyond the scope of science and technology solution unless political action results in behavioural change (Sadati et al., 2020).

5.3 Science and Technology studies

While the Risk Society focuses on socio-technical ambiguities and paradoxes and how new technologies have brought with them new risks, Science and Technology Studies (STS) focus on the ways in which scientific facts and technologies are produced. Importantly, STS emphasise the socially constructed nature of scientific facts and technologies (e.g., Hutchison, 2016, Sismondo, 2007). They thereby question the ‘naturalised’ portrayal of scientific findings as neutral facts, a view which often dominates in the natural sciences. Instead, STS point to the many ways in which the production and employment of scientific facts are always embedded in the fabrics of the societies in which they arise and are employed and promoted. This fabric consists of cultural, social, political and economic processes and structures as well as the material forms which express and shape these, for example, in the form of laboratory equipment, university buildings, scientists’ bodies and the phenomena that are being studied (e.g. microbial organisms and the drugs developed to combat these). Where Discourse Analysis focuses on the ways in which phenomena are constructed through particular representations, STS in contrast take a broader look at what makes scientific facts and technologies and emphasises the material nature of the things that together produce a fact or technology. Representations are thus just one aspect and even these exist mainly in material forms such as papers, ink, and the many different elements and components that go into producing computer laptops and servers as well as laboratory equipment.

STS do not represent a unified field of study with a shared theoretical starting point. Instead, there is a diversity of approaches with different emphases (Sismondo, 2007). One of these is Actor Network Theory (ANT), which emphasises the connections amongst humans, other species, technologies and material objects (Law, 1992, Ritzer, 2004, Sismondo, 2004). Whereas longstanding social theory has seen agency as limited to humans, consciousness and intentional actions (or as very limited in general), ANT views agency as something that also characterises other living as well as non-living entities and which arises in these interconnected networks. It thus de-centres humans as the only agential actors and instead speaks of multiple and diverse actants that together make up and shape networks (Sovacool and Hess, 2017). Likewise, significance is seen to arise out of the relationships between these



multiple and diverse actants rather than as residing in the actants themselves (Law, 1992, Ritzer, 2004). In the case of AMU and AMR, actants might include microorganisms, genes, pharmaceutical drugs, farm animals, feeding troughs, refrigerators, supermarkets, markets, and laws, as well as farmers, farmers' family members, veterinarians, consumers, laboratory technicians and politicians (to mention but a few). All of them 'do' things to the other members in the network, though this doing does not need to be intentional. Importantly, even where conscious intentions exist these are not given precedence or assumed to automatically lead to desired outcomes. Outcomes are thus always properties of the network rather than of individual actants. It is the relationships between all these different actants together which create AMR and invest it with significance.

Application to ROADMAP: Science and technology studies can help us focus on what scientific findings do as well as what things they may preclude, as explained by Hutchison: '[...] the formulation of AMR as a scientific object can be reviewed in the light of the linguistic and relational accounts within science, policy and society. Such work allows us to reconsider the ways we imagine AMR, and allow for the emergence of alternative ways to construct AMR as problem, offering other possible avenues for future intervention.' (2016, p. 27). Some STS approaches focus mainly on describing the processes through which scientific facts are produced and become widely circulated and accepted. While these approaches are usually critical in their stance, some STS take a more overtly activist approach. These latter aim to hold techno-scientific knowledges accountable and ensure they promote the interests of the public rather than a minority of private individuals or to the detriment of the common good (for example, as in the case of the development of weapons of mass destruction on the basis of nuclear physics or microbiology)(Sismondo, 2007). Descriptive and more activist approaches are not necessarily at odds with each other and many studies may contain components of both (Sismondo, 2007). This is particularly relevant for a project such as ROADMAP which has an applied focus on an issue relevant to public interests.

5.4 Supply Chain Analysis

Supply Chain Analyses look at the world of farming as part of economic systems which shape the opportunities and constraints for different types of farming systems. They do this by analysing production systems, such as food production, in terms of decisions and structures within the whole supply system including inputs, production, processing and marketing and consumption (Therond et al., 2017). Supply Chain Analyses generally start from the premise that in order to understand production systems and how to bring about change, all the different parts of the production system need to be taken into account. This is because they are highly interconnected and changes in one part of the supply chain will impact on another. In the case of antimicrobial use in the livestock sector the food supply chain can be divided into:

- i. inputs (feeding and breeding industries, pharmaceutical companies, veterinary practices and wholesalers);
- ii. production (depending on the sectors: breeders, hatcheries, farrow-to-finish farmers etc.);
- iii. processing (slaughterhouses, processors, food industries);
- iv. marketing & consumption (retail industry, restaurants, consumers).

Many analyses of supply chains identify and characterise different types of supply chains and look at the implications of these differently organised supply chains. In relation to food supply chains, these include for example conventional supply chains and alternative or quality supply chains (Marsden et



al., 2000, Therond et al., 2017). Conventional supply chains usually involve the use of conventional inputs and production processes, large and often widely dispersed distribution channels, the involvement of multinational corporations at many levels of the supply chain and the commoditisation of goods sold. Alternative or quality supply chains may involve niche production methods such as organic or permaculture, often shorter and more spatially contained distribution channels, smaller organisations and potentially more equal power relations between actors and the quality or niche aspects of the goods communicated to consumers at purchase (Marsden et al., 2000). Some studies have sought to combine an analysis of food supply chains with additional factors such as biotechnical aspects of farming systems (e.g., Therond et al., 2017).

As in most fields, there is a large diversity within Supply Chain Analysis. While the more mainstream approaches are either descriptive or rest on the assumption that problems can be solved by creating the right kinds of supply chains, other strands take a more critical perspective explicitly focusing on how issues of power and inequality are inbuilt into the logic of supply chains and markets and why efforts at reforms may not result in radical change if these underlying logics and power differentials are not addressed (Busch, 2016). This can for example be seen in issues around certification and the creation of standards. While certifications and standards are often created through the coming together of different players in the supply chain, the voices of larger players such as retailers carry more weight than others (Loconto and Busch, 2010, Ransom et al., 2013). As a consequence, these larger players can use the certification process to shape the supply chain so that it best suits their interests (Ransom et al., 2013). Even amongst players who nominally take up the same position in the supply chain, certification and standards may lead to the exclusion of some (Busch, 2016). This is for example seen amongst farmers, where small-scale farmers often cannot afford the cost associated with the certification process or may not be able to live up to the required standards.

Application to ROADMAP: Focusing on the supply chain can help to identify potential points which could impact AMU (e.g., supermarkets imposing particular standards or information regarding AMU), but can also point towards barriers. Different supply chain structures may have different impacts on AMU and present different challenges as well as opportunities for change though the more critical approaches to supply chains suggest that altering supply chains alone may not change underlying dynamics and power structures. In contrast to some of the other approaches listed here, Supply Chain Analysis focuses on structures and formal organisations. It can therefore be a useful tool for analysing structures that constrain or enable the actions of individuals, for example in the form of suppliers of antimicrobials and supermarket chains with particular production requirements. However, as it is less concerned with individuals and their practices, it will inevitably leave out many of the other aspects that shape what happens at the farm level.

5.5 Social Practice Theory

While Science and Technology Studies focus on the production and practice of science and technologies, Social Practice Theory focuses on everyday practices and how these arise, are sustained, changed and become extinct. Practices are here understood as largely routinised forms of behaviour that consist of different elements such as embodied doing, know-how and skills, ideas and meanings, objects and materials. Pantzar and Shove (2010) discern between three broad groups of elements of practice, namely, skills (including forms of knowing), images (including meanings and symbols) and materials (including objects and technologies). Practices consist of particular ways in which these elements come together to form more or less coherent and recognisable entities. Importantly, practices need to be enacted in order to persist over time. Each time a practice such as an animal health check is enacted



its different constitutive elements are activated (e.g., the bodily skill of handling animals, knowledge of animal behaviour and diseases, the animal, diagnostic instruments, animal handling facilities and meanings and images associated with caring for animals). Practices change when the links between its elements change or new ones become part of the practice (e.g., new diagnostic or treatment methods as well as new farming routines or perceptions of animal welfare and behaviour). Different elements of practice do not usually all change at the same time, but, changes in one element can lead to changes in others.

Different practices together form systems of practice, such as animal care or farming practices. At the same time, individual practices usually cut across different domains and influence. For example, animal health checks are parts of farming practices as well as veterinary practices and slaughterhouse practices. At the same time, practices are influenced by other systems and their elements. Again, in the case of animal health checks this can, for example, be influenced not only by the availability of elements directly related to health checks (such as diagnostics and animal handling facilities) but also by communication and transport systems (e.g., computers, phones, internet connections, cars, tractors, roads, farm tracks, etc.) which may influence access to (different types of) information, animal health care products and services.

Importantly, many practices are carried out in a largely routinised fashion where they are not actively chosen or questioned, but just enacted as ‘the way things are done’. The focus of Social Practice Theory is, therefore, as much on the continued existence and reproduction of practices as it is on their changes. While other approaches, such as Multi-level Perspectives on Transitions (see section 3.2), focus on the successful spread of innovation and end the story where these have become established (or not), Social Practice Theory is equally interested in what makes practices persist over time as well as how they change.

In relation to antimicrobials in livestock farming, Social Practice Theory can help understand how pharmaceutical substances come together with other elements. For example, how animal housing relates to ideas and norms about meanings of animal health and good husbandry, legislation and retailers’ standards, availability of veterinary services, the characteristics of the animals and microbes, and other practices such as those related to crop cultivation or family life. In some respects, this may seem very similar to approaches such as ANT (see section 3.6). However, the main differences include the focus on the everyday in practice theory and the discernment of different elements of practices, including meanings, which are given less emphasis in approaches such as ANT.

Application to ROADMAP: A criticism of Social Practice Theory is that it cannot easily be used to direct and govern changes and transitions in practices and that the influence of wider structures and context may sometimes disappear from view (Sovacool and Hess, 2017). Furthermore, with the focus being on practices as enacted by individuals, practice theory is less useful in understanding changes at higher levels (e.g. legislation and supply chains).

5.6 Relationality, More-than-human approaches and Care

Recent decades in the social sciences have seen a growing interest in what has been called relationality and the ‘more-than-human’ (Whatmore, 2006). This interest does not constitute a homogenous field or approach but is reflected in diverse forms and fields (including ANT as outlined in section 3.6). This development has been linked to a renewed interest in materialities, embodiment and the way in which bodies and materials are entangled in diverse relationships which produce meanings, practices and material outcomes. In contrast to more-than-human approaches, early studies of care focused mostly



on human-to-human care. However, care studies (and theoretical considerations around care) share a focus on relationality with more-than-human approaches and in recent years these different approaches have been brought together to look at care in the context of more-than-human relations. Here, we first briefly outline some basic ideas from Care Theory before returning to the coming together of care and the more-than-human.

Within Care Theory, humans are seen as fundamentally embedded in social relations on which they depend for the fulfilment of their needs (Puig de la Bellacasa, 2017, Tronto, 1993). Care can be defined as attending to the needs of others (whether human or more-than-human) in a very broad sense. It is defined by Fisher and Tronto as, ‘everything that we do to maintain, continue and repair our ‘world’ so that we can live as well as possible.’ (Tronto, 1993, p. 103). In the view of Care Theory, everybody is dependent on receiving as well as giving care (Puig de la Bellacasa, 2017). Giving and receiving care and being embedded in social relations is part of what provides life with meaning and value. Care is thus understood both as broader and more fundamental than the limited number of activities which traditionally have been associated with women and the domestic sphere (e.g. in the form of caring for children and the elderly). As mentioned above, these relations of care were initially mostly understood as pertaining to other humans though more recent studies have extended this to include the more-than-human. The focus on relations means that the field of enquiry is widened to include emotions, morality, multiple values, and situated and embodied forms of knowledge, all of which are seen as relevant and legitimate (Puig de la Bellacasa, 2017).

Care theory has its roots in feminist theory and as such includes a focus on power differences amongst those making decisions about care, implementing care and receiving care, as well as how these differences structure access to care and to resources available for caring (Puig de la Bellacasa, 2017, Tronto, 1993). Relationships of care are thus always situated within existing power dynamics and can both help to reproduce and uphold existing power relations as well as to challenge these (Puig de la Bellacasa, 2017). It is therefore necessary to take into account these power relations as well as questions about the ends and purposes of care, different ways in which care is enacted, and different preferences for how needs are met (Tronto, 2010).

A growing body of work has developed theory specifically at the intersection between care and more-than-human scholarship (e.g. Mol et al. 2010; Puig de la Bellacasa, 2011; Greenhough, 2011; Joks & Law, 2017; Daniels & Mather, 2017; Davies et al., 2018; Donald, 2019). Whilst disparate in many ways, this work is united in its de-centring of the human subject with roots back to Science and Technology Studies and ANT. Extending Tronto and Fischer’s seminal conception of care, Puig de la Bellacasa (2017) asserts that “care is everything that *is* done (rather than everything that “we” do) to maintain, continue, and repair “the world” so that *all* (rather than “we”) can live in it as well as possible. That world includes ... *all* that we seek to interweave in a complex, life-sustaining web (modified from Tronto 1993, 103)” (p.161).

Rather than being conceived of solely as something a human does to another human or animal, care is considered a more-than-human relational achievement in which important work can be done by creatures, plants, technologies, other objects and infrastructures. Moreover, after Barad (2007), care cannot be seen solely as the product of *intentional* agency but of a mutual, emergent unfolding through practice: “Care is not one way; the cared for co-forms the carer too” (Puig de la Bellacasa, 2017, 219). Even notions of a particular species and their individuals being discrete, singular, binary givers or receivers of care is troubled by revised understandings of them as permeable, symbiotic communities (e.g. Haraway, 2016; Lorimer, 2016). Relational, more-than-human approaches to care are in their emphasis on connections and emergent outcomes closely linked to approaches such as ANT



which similarly focus on connections between human as well as more-than-human actants (section 3.6).

Puig de la Bellacasa (2017) underlines three key dimensions of care:

1. Care as labour/work - entailing material, concrete practice;
2. Care as affective relations - affect as embodied, not necessarily positive (could involve pain and tedium as much as affection or joy);
3. Care as ethics - e.g. moral imperatives or obligations to look after another

These dimensions “are not necessarily equally distributed in all relational situations, nor do they sit together without tensions and contradictions, but they are held together and sometimes challenge each other in the idea of care” (Puig de la Bellacasa, 2017 p. 5). More-than-human caring happens through a profoundly embodied, reciprocal affecting and being affected (Despret, 2004). Indeed, work done in multispecies ethnography makes the case that in order to generate more liveable worlds with nonhuman others, we need to learn to, notice, ‘listen’ to, and be more attentive to nonhumans (Kirksey & Helmreich, 2010) and indeed find better ways to let animals themselves ‘speak’ on their own terms (Birke, 2014). Therefore, having affect as a central pillar of care - and the work done by emotions - is particularly helpful when examining more-than-human creatures since they tend to articulate and respond through bodily movements, gestures, comportments, multiple senses, and biochemical signalling in ways that can be obscured when we foreground human ways of being and knowing, especially by Western sensory hierarchies privileging vision over touch (Myers, 2015). There is a need to attend to how such affective ecologies are “contoured by affinities and repulsions” (Hustak & Myers, 2012, p. 79) and how they are produced through particular temporalities (Puig de la Bellacasa, 2015) and spatialities of care and its governance (e.g. Conradson, 2003; Popke, 2006; Philo & Parr, 2019). Attention to the geographies of care - including the mobilisation of proximity and distance - provide a useful link between biosecurity (section 3.4) and care framings, as well as to notions of good farming (section 3.8) and wider moralities of agricultural systems, such as moral legal geographies of ends, means and identities (Brown, 2007), and other legal geographies of more-than-human care (Srinivasan, 2013).

These points underline how care is always situated and multifaceted - “there can be no singular vision of what care is or what it might become.” (Martin et al., 2015: 10) - and thus always contingent and power-laden. As Martin et al. (2015) explain:

“Care is a selective mode of attention: it circumscribes and cherishes some things, lives, or phenomena as its objects. In the process, it excludes others. Practices of care are always shot through with asymmetrical power relations: who has the power to care? Who has the power to define what counts as care and how it should be administered? Care can render a receiver powerless or otherwise limit their power. It can set up conditions of indebtedness or obligation. It can also sediment these asymmetries by putting recipients in situations where they cannot reciprocate. Care organizes, classifies, and disciplines bodies” (p.3).

Acknowledgements that care is contested, conflicted and non-innocent are imbued with an imperative to attend to care because its politics are always already circulating, including in the logics and gendered, racialised, colonial networks of capitalist accumulation (Murphy, 2015; Haraway, 2016). In the context of livestock farming, these asymmetries are found between humans and the farm animals as well as amongst humans working and living in farm environments (farm owners, farm workers, women,



family members, external advisors, veterinarians, etc.). These asymmetries have important implications for decision making, enactment and reception of care. In the ROADMAP project a number of case studies (termed ‘marginal case studies’) have specifically been selected to represent and investigate how the marginal status of some human as well as more-than-human influences matters of care.

This means that care can have darker sides, for example, when caring for particular creatures entails the killing of others. Care can be enlisted in violence and be used to legitimise and render it invisible (van Dooren, 2015). In livestock production, care is always practiced through asymmetrical relations of power since humans and various animals do not typically possess the same capacities to articulate and respond - and therefore be visible - within human-defined frameworks of wellbeing. The tool belt of care practices for animal health and biosecurity can include culling, isolation, differential forms of attention and attentiveness, and other forms of disciplining livestock bodies so as to ensure a range of care outcomes from merely surviving to thriving. It then behooves us as researchers of agricultural care practices to attend to the very conditions in which particular forms of care become possible or precluded (after Martin et al., 2015) and what that means for questions about how best to care; how care is cultivated and at what cost; who cares for whom, what, why; what counts as care; as well as the way particular mobilisations of care implicate particular ways of constituting more-than-human relations. In other words, how care relations become articulated, known and responded to. Practical, affective and ethical relations of care will be used and put to work in a wide variety of ways in AMU, and sometimes in ways that are taken-for-granted and relatively obscured. As Puig de la Bellacasa (2017, p. 5) suggests more broadly, “staying with the unsolved tensions and relations between these [three] dimensions [care as labour, care as affective relations and care as ethics] helps us to keep close to the ambivalent terrains of care”.

Core to this body of work is thus the assertion of care as a form and practice of critique, yet one that seeks to re-assemble rather than just take apart its relations (Puig de la Bellacasa, 2017). We can identify in the work of Haraway (2008; 2016) how some key elements of care are operationalised in such a way. She urges an openness and attentiveness to the multispecies webs in which one is already entrained, where “[c]aring means becoming subject to the unsettling obligation of curiosity, which requires knowing more at the end of the day than at the beginning” (Haraway, 2008, p.36). Caring thus means staying with the task and sometime burden of knowing even when that becomes difficult or seemingly hopeless. It means following traces of contingency in ways that make present key absences and consequences. ‘Staying with the trouble’ in this way is suggested, not as a disembodied, dispassionate form of knowing, but, drawing on Despret (2004), as a willingness and ability to be moved. It is a way of cultivating mutual capacities to be affected, and through such affective exchange thus rendering each other response-able, capable of responding in ways that allow living and dying well. Part of this, for Haraway (2016), means creating the conditions in which we can imagine and re-story possibilities for more-than-human practices of care to be otherwise, which could be through artistic as much as scientific ways of knowing.

Application to ROADMAP: A more-than-human care lens can help the study of AMU at the farm level in a number of ways by:

- enabling us to examine specifically situated mobilisations of care and ask: What does it mean to care in various parts of AMU assemblages and with what effects? I.e. allows us to look at the farm as a site and coalescence of care, and thus to invite a deeper understanding of how particular sets of more-than-human relations are made liveable
- taking us beyond livestock as passive recipients of care in farm-level practices but rather as co-active in the mutual emergence of care practices along with the wider web of humans, microbes, medicines, feed, barns, fields, fences, bedding, cattle crushes, and so on, being alive



to the situatedness of care practices within particular vulnerabilities, spatialities (including proximities and distances) and temporalities.

- invite us to identify (sometimes taken-for-granted) practical, affective and ethical mobilisations and contingencies of care practices in livestock production, and make connections between them
- helping us situate AMU in real fleshy human and nonhuman bodies and materialities, whilst encouraging tracing the power-laden relationships that co-constitute them outwards from the farm level
- providing a framework for dealing with the complexities, ambiguities and conflicted dimensions of more-than-human care
- acknowledging thinking ‘with care’ constitutes a solid, reflexive foundation for considering our own roles and accountabilities as researchers as we engage and remake AMU worlds in particular ways (Martin et al., 2015);
- exploring the prospects of doing AMU more care-fully: making space for us to imagine and develop alternative possibilities for thinking about and enacting AMU: “Paying attention to practices of care can be a way of getting involved with glimpses of alternative, liveable relationalities, with other possible worlds in the making” (Puig de la Bellacasa, 2017: 170)
- linking farm-level practices of care to the practices of care done elsewhere (e.g. by vets, scientists, policymakers, auctioneers, pharmaceutical personnel etc)

Application to ROADMAP: Similarly to social practice theory, it can be difficult to reconcile analysis carried out through the lens of practices of care with an understanding of governance and higher level contextual mechanisms factors.



6.0 Classifications of different approaches and fit with WP2

In projects such as ROADMAP, theoretical frameworks often consist of the adoption or adaption of an existing theory or approach to structure the research and to guide questions, data collection and analysis. This helps to ensure both consistency and transparency throughout the research (Grant and Osanloo, 2016). However, when dealing with complex issues such as AMU and AMR in large scale projects aiming to understand different aspects at different scales, using a single theoretical framework may not be feasible or the best approach. A different way of using theories is to let theory follow from data or to juxtapose insights resulting from different approaches, thereby ‘triangulating’ research findings and providing different insights (Sovacool and Hess, 2017), whether or not these sit easily alongside each other. For WP2 we have developed a framework which emphasises three key approaches: triggering change, the good farmer and the supply chain thinking, while identifying relevant other concepts and approaches which can inform data analysis.

To look at the potential contributions of different approaches it can be helpful to try to order them according to their focus, scale, assumptions and goals. Sovacool and Hess (2017) provide different classifications of some of the theories which have been presented in the preceding sections. Their first classification relates to where theories sit in terms of focusing on agency, structure, meaning, relations and normativity. While agency, structure and meaning constitute different ‘poles’ in a triangle, relational approaches are seen to sit somewhere in the middle of these approaches. ‘Relational’ is, in this typology, used in a broad sense to include approaches such as ANT, Social Practice Theory, Care Theory and Multi-Level Perspectives on Transitions. ‘Normativity’ as used in this typology can either represent separate approaches, such as political ecology and social justice approaches where the normative element is an inherent focus of the approach, or it can be an aspect that is sometimes incorporated in other approaches. An example of the latter would be Science and Technology Studies that not only describe the socially constructed and contingent nature of particular scientific facts and technologies, but which set out to democratise science and ensure that it promotes the public good (Sismondo, 2007). Given that ROADMAP WP2 wants to go beyond individually focused approaches and to look at how practices at the farm level are influenced by different actors as well as the wider context, the relational category as defined in this typology seems to provide a promising avenue to pursue. While the ROADMAP project as a whole also has a normative aspect in terms of aiming to contribute to prudent AMU, WP2 mainly focuses in the first instance on understanding existing situations as well as past changes. This understanding together with information from other work packages will subsequently be used to identify potential points and forms of change.

The second typology presented by Sovacool and Hess (2017) classifies approaches according to their goals and assumptions discerning functionalist-institutionalist, interpretivist, critical humanist, and conflict theories (Table 1). As pointed out by the authors, these are ideal types in a Weberian sense and individual theories and their applications may therefore span or potentially be placed in several categories (depending on how they are employed)(Sovacool and Hess, 2017).



Table 1. Classification of theories according to their goals and assumptions (adapted from Sovacool and Hess, 2017).

	Functionalist Institutional	Interpretivist	Critical Humanist	Conflict
Goals	To search for regularities and sources of disequilibrium	To describe and understand social complexity and multiple perspectives	To describe and problematize assumptions in order to identify potential for change	To identify and modify patterns of domination
Assumptions	Society as a self-regulating system	Society as socially constructed action	Society as historical change and development	Society as a system of struggle and oppression
Topical focus	Norms, values, and institutions	Discourse, practice, and culture	Historical change and cultural difference	Societal conflict
Approaches	Refinement through causal analysis	Discovery through code analysis	Insight through critical analysis	Liberation through structural analysis
Methods	Probing representative samples of subjects	Identifying specific cases, questioning informants	Comparing specific cases or existing research, questioning assumptions	Evaluating historical evidence and structural conditions
Potential placement of theories	Supply Chain Analysis Multi-Level Perspective on Transitions	Relational approaches	Multi-Level Perspective on Transitions Discourse Analysis Biosecurity studies Supply Chain Analysis Risk Society	Care theory
	Good Farming Triggering Change			
		Social Practice theory Discourse theory Science and Technology studies Care theory		

As the focus of ROADMAP WP2 is to gain a better understanding of what happens at the farm level in terms of AMU, approaches sitting somewhere in between interpretivist and critical humanist approaches in this classification would seem promising. This would point towards the usefulness of approaches such as Social Practice Theory, Discourse Analysis, Science and Technology Studies, and Relational, More-Than-Human approaches and care.

Finally, theories can also be classified according to the scale at which they focus although some theories may cut across scales or be applied at different scales. Approaches such as Discourse analysis, Risk society, and Food chain analyses typically focus on the level of society or the market while care theory, practice theory, relational approaches and good farming studies typically focus more at the local level. These latter approaches may therefore be more useful for the farm level focus of WP2. Meanwhile, Biosecurity studies, Transition theory and Science and Technology studies focus on interactions between and across different levels and can therefore be useful in linking what happens at the farm level



to the wider context, and provide bridging points between WP2 and other work packages of the ROADMAP project.

7.0 Methodological applications

This research seeks to understand how and why farmers adapt their animal health practices in relation to anti-microbial. The theoretical framework recognises the importance of cultural (i.e. the concept of good farming) and structural inertia and triggers in relation to changes in the use of anti-microbials. Methodologically, this requires in-depth attention to the complex interplay between decisions about the use of anti-microbials in relation to other competing priorities, in ways that reveal how dimensions of change and inertia change and adapt over time. At the same time, it is important to distinguish broad patterns and approaches to AMU

7.1 Biographic Narrative Interpretive Method

The Biographic Narrative Interpretive Method (BNIM) (Wengraf, 2004) which has been used successfully in previous analyses of farmers' herd-health decisions (Chan and Enticott, 2019, McAloon et al., 2017, McFarland et al., 2020) and other animal health research (Enticott, 2018, Enticott, 2019). The BNIM is a semi-structured qualitative interview technique designed to elicit narratives of how changes occur and unfold in specific contexts as seen from an individual's own perspective. This is achieved by providing the research participant to reflect at length upon a specific issue and consider how change occurs. For the purposes of this research, the BNIM therefore allows research participants (i.e. farmers and vets) to reflectively think through their animal health decisions to reveal their contextual and situated nature. This reflective process emphasises the importance of the discursive consciousness in capturing the multi-faceted nature of decision-making, as opposed to the practical consciousness which emphasises easier, one-dimensional explanations that reflect social expectations (e.g. cost as reflective of business acumen). This process is particularly valuable for capturing the 'hard to articulate' dimensions of animal management, such as those embodied, material and visceral dimensions.

In practice, the BNIM captures the complex influences on farmers' decision making through its reliance on two key questions. The first, known as the Single Question for Inducing Narrative (SQUIN) provides the opportunity for the research participant to talk at length and uninterrupted through their experiences of managing animal health and the changes that they have made. Importantly, the reliance on narrative means that the SQUIN can be framed in ways to capture the multiple influences upon decision making by situating the research interests (i.e. AMR/AMU) within its broader context (i.e. animal health and disease management). Secondly, the narrative is developed through the use questions known as Particular Incident Narratives (PINs). These questions are designed to elicit further information in relation to the specific narratives of change provided by the research participant. Moreover, they can be tailored to dimensions specific to the theoretical framework to explore their relevance in relation to the narratives of change provided.

7.2 Discourse analysis

Discourse Analysis looks at the ways in which phenomena are established, defined and dealt with through forms of representation and associated practices (Chandler, 2019). Similar to Science and Technology Studies (see section 3.6), Discourse Analysis pays close attention to the relationships which give rise to and shape particular discourses. However, where Science and Technology Studies focus on the way in which diverse elements come together in scientific practices to create scientific facts as well



as technologies, Discourse Analysis focuses more specifically on forms of representation. Discourse Analysis can help bring to light not only the kinds of understandings and relationships on which, for example, current AMR policies rest, but can also point to the things that are left out, and to the consequences of framing problems of AMR in particular ways rather than others (Chandler et al., 2016b). Discourses shape how we understand the world and what we understand as the best way to act. Particular discourses will thus locate responsibility in particular places and groups (e.g., the farmer, the vet, the hospital the state or the pharmaceutical company as responsible for AMR), promote particular moralities and will point to particular solutions and points of intervention (e.g., regulation or incentives aimed at farmers, information provided to consumers, development of new AMs or vaccines by pharmaceutical companies) (Chandler, 2019, Chandler et al., 2016b).

Often, discourses will cover and link different fields so that the logic applied in one field gets imported and applied to another field. Brown and Nettleton (2018) for example show how economic terminology and logic is applied to the biology of antimicrobial resistance and vice versa. Similar to the work within Science and Technology Studies, Discourse Analysis can thus help us to unpack how particular logics come about and how discourses shape responses and may contribute to making some potential responses disappear from view while others come to be seen as natural.

7.3 Typology development: The quantitative survey

The path dependencies of contemporary farms are implicitly recognised in the numerous typologies of farmers developed in the academic literature. These typologies seek to bring order to the heterogeneity of agricultural producers, categorising farmers, their attitudes and practices into categories or idealised types (Sutherland et al. 2011). A typology approach enables the design and implementation of interventions and policies that are tailored to the specificities of different and distinct characteristics (Lopez-Ridaura et al. 2018; Tittone 2014). Typology construction is particularly common for analysis of surveys, providing useful insights into patterns in responses.

Two quantitative questionnaire surveys will be conducted within the project, among farmers and veterinarians. The aim is to understand how antibiotic use and animal health management practices vary between different countries, sectors and production systems. These questionnaires are composed of three parts: the social characteristics of the respondents and the technical and economic characteristics of the farms or veterinary practices; the working conditions, in particular the adaptations made over the last year to cope with the Covid crisis; the prescription and use of antibiotics, including perceptions of the problem of antimicrobial resistance.

These questionnaires aim to provide sociological insights into how antibiotics are perceived and used in animal farming, and the structural factors (working conditions, etc.) that influence these practices. The interdisciplinary literature on this subject has produced several quantitative surveys in recent years that have mainly considered the problem from a behavioural perspective (TBP approaches in particular) (Speksnijder et al., 2015 ; Visschers et al., 2015 ; Coyne et al., 2018). They often highlight a lack of knowledge on the part of farmers and a need for education. However, they are limited by this knowledge-deficit model approach, which tends to reduce antibiotic use to psychological dimensions, such as risk aversion, without taking into account the social and structural constraints that influence the stakeholders (Tompson & Chandler, 2021). ROADMAP is inspired by another literature on antibiotic resistance, more developed in the field of human than animal health, which points to these dimensions (Broom et al., 2014, 2016, 2020; Chandler, 2019 ; Willis & Chandler, 2019).

A secondary objective associated with this questionnaire survey is to establish a typology of farmers and veterinarians in relation to their antibiotic prescription and use practices. Based on typologies of



farming professional identity (care-oriented; business-oriented; community-oriented) inspired by literature in the sociology of animal health (Shortall et al., 2016, 2018 ; Adam, et al. 2017, 2020 ; Burton et al, 2020), the results of the questionnaires should make it possible to test the hypothesis that the professional identities of farmers and veterinarians are a factor in their antibiotic use patterns. Care-oriented refers to farmers and veterinarians who place animal health and welfare at the heart of their professional practice and who are constantly seeking to adapt their profession to these issues. Business-oriented refers to actors who are more concerned with the productivity and profitability of their professional activity and for whom the use of antibiotics is considered in this context. Community-oriented refers to farmers and veterinarians who are concerned about public health and environmental issues, and who are concerned about the social demands of consumers in terms of agricultural production models and food quality.

In total, these quantitative surveys will make it possible to identify both structural and cultural/identity factors that influence antibiotic use among animal health professionals. The methodological aspects are not detailed in this deliverable, which is focused on the theoretical framework, but the questionnaires will be carried out in accordance with the general rules of the RGPD and the Grant Agreement.

8.0 Conclusion

Based on the review of different approaches with their different foci, goals and assumptions, a number of approaches stand out as particularly useful to help gain a better understanding of AMU at the farm level. These include Relational, More-than-Human approaches and care, and Social Practice theory which can be applied at the farm level and focus on the intersection between structures, agency and meanings. Furthermore, these approaches straddle ‘interpretivist’ and ‘critical humanist’ categories with the goal to respectively ‘describe and understand social complexity and multiple perspectives’ and ‘describe and problematize assumptions in order to identify potential for change’ (Sovacool & Hess, 2017, p.735). Some of these, such as More-than-Human approaches and care, are already being brought together to provide a focus on care within entangled human and more-than-human relationships. Bringing on board Social Practice Theory can help to provide a focus on the way in which meanings, materials and skills come together in the enactment of practices and how their transient relationships. Additionally, Biosecurity Studies and Multi-level Perspectives on Transitions can help to provide the links to other parts of the project which focus on larger scales.

While attempts have previously been made to integrate some of these approaches such as, for example, the Multi-level Perspective on Transitions and Social Practice theory, this can risk obscuring important differences and insights that different approaches can provide (Hargreaves et al., 2013, Sovacool & Hess, 2017). Instead, it can be more fruitful to explore where different approaches will lead, what insights they produce and where there are points of intersection between them (Hargreaves et al., 2013, Sovacool & Hess, 2017). This is not always straightforward and needs to be done mindfully of the different assumptions and methodological approaches entailed by various theoretical approaches. While approaches may sit in uneasy tension alongside each other, it nevertheless seems a strategy suited for a large scale, complex project such as ROADMAP, where partners bring different expertise and viewpoints to the project. This is, therefore, the approach taken in this preliminary report on the WP2 theoretical framework, which allows us the space to adapt and learn as we proceed with the research. While we have highlighted the particular promise of approaches, such as relational ones with a focus on the more-than-human and care or Social Practice Theory, we do not yet attempt to generate an integration of these different approaches, but keep them as lenses through which to explore AMU at the farm level.



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10.0 Appendix : questionnaire surveys



Information

About this Survey

The aim of this survey is to find out about the impact of the Covid-19 / Coronavirus crisis on farmers and their animal health management practices. We are interested in how farmers have been affected and the changes you have made to your business and your animal health practices during the pandemic.

Who is Involved?

This research is funded by the European Commission as part of the ROADMAP project which is analyzing changes in animal health practices on farms, focusing on the reduction of antimicrobials. More details can be found on the project website : <https://www.roadmap-h2020.eu>

Who can complete this survey?

This survey is designed to be completed by anyone over the age of 18 living in [country] who lives and/or works on a farm



Section A: Section 1: About You and Your Farm

We'd like to ask you some brief questions about yourself.

A1. In which country do you work ?

Belgium

France

England

Scotland

Wales

Ireland

Italy

Spain

Germany

Sweden

Norway

Nederland

Vietnam

Portugal

Denmark

Other



A2. In which region of this country do you live?

- Auvergne-Rhône-Alpes
- Bretagne
- Bourgogne - Franche-Comté
- Centre Val de Loire
- Corse
- Grand Est (Alsace, Champagne, Lorraine)
- Hauts de France
- Ile-de-France
- Normandie
- Nouvelle-Aquitaine
- Occitanie (Midi-Pyrénées, Languedoc)
- Pays-de-la-Loire
- Provence - Côte d'Azur
- Nouvelle option pour la réponse
- Nouvelle option pour la réponse
- Nouvelle option pour la réponse

A3. What is your age?

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65-69
- 70-74
- 75-79
- 80-84
- 85+



A4. What is your gender?

Male

Female

Prefer to self-describe

Rather not say

A5. What is your main activity ?

Animal production

Crop production

Equivalent

A6. What is your main animal production?

Dairy cows

Veal Calves

Beef cattle

Poultry : broilers

Poultry: Hens / Eggs

Pigs

Rabbit

Sheep



A7. How many milking cows do you have on your farm ?

- 1 - 10
- 10 - 30
- 30 - 50
- 50 - 70
- 70 - 100
- 100 - 150
- 150 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 1000
- 1000 +

A8. Milk yield per cow :

- 1-3000
- 3001-6000
- 6001-8000
- 8000+



A21. Do you have a second animal production ?

- Dairy cows
- Beef cattle
- Poultry : broilers
- Poultry: Hens / Eggs
- Pigs
- Rabbit
- Sheep
- None

A22. Do you work in a mixed farm ?

- Yes
- No

A23. What is your role on the farm?

- Owned
- Manager
- Farm worker

A24. What best describes the farm you are working in ?

- Independent farm
- Cooperative farm
- Integrated farm
- Nouvelle option pour la réponse

A25. Tell us more about your production :

- | | Yes | Uncertain | No |
|--|--------------------------|--------------------------|--------------------------|
| I am part of a “antibiotic free” quality scheme | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| The farm receives a financial incentive for a sharp reduction in the number of antibiotic treatments | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I am part of an organic farming label | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I am part of other quality labels | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| The farm receives a penalty if I treat animals with antimicrobials | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |



A26. Have you reduced antibiotics ?

Yes

No

A27. If yes :

Over the past 5 years

For more than 5 years

For more than 10 years

I've always used very few antibiotics

A28. If no :

I don't consider this as a priority

The characteristics of my farms don't allow it

I've always used very few antibiotics

A29. In general, what is important to you as a farmer ?

1 is not important ; 5 is very important

	1	2	3	4	5
Taking care of the environment	<input type="checkbox"/>				
Spending time with animals	<input type="checkbox"/>				
Providing good products for the consumers	<input type="checkbox"/>				
Ensuring animal health	<input type="checkbox"/>				
Protecting public health (human health)	<input type="checkbox"/>				
Giving a good image of the farming sector	<input type="checkbox"/>				
Using the most up to date processes and technologies	<input type="checkbox"/>				
Ensuring business profitability	<input type="checkbox"/>				
Taking responsibility in my community	<input type="checkbox"/>				



Section B: Section 2 : Just a few questions about how this last year has impacted (or not) your work

In this section, we are interested to know how the Covid-19 crisis has affected the way you manage your work.

B1. Thinking about your experiences during the Covid-19 crisis, please indicate the extent to which you have ...

1 is not at all ; 5 is very much

	1	2	3	4	5
Been proud of being a farmer	<input type="checkbox"/>				
Felt particularly useful	<input type="checkbox"/>				
Felt under pressure to produce food for the country	<input type="checkbox"/>				
Been worried about my own health and my family's	<input type="checkbox"/>				
Been worried about the health of my animals	<input type="checkbox"/>				
Been confident about the future of my farm	<input type="checkbox"/>				
Not felt particularly concerned about the crisis	<input type="checkbox"/>				

B2. Thinking about your work experiences during the Covid-19 crisis, please indicate whether you agree with the following...

1 is strongly disagree and 5 is strongly agree

	1	2	3	4	5
Because of the Covid-19 crisis, the stresses of my job were much harder to handle	<input type="checkbox"/>				
My work hasn't been impacted at all	<input type="checkbox"/>				
My business hasn't been impacted at all	<input type="checkbox"/>				

B3. During the last year, have you or the farm owner made any significant change in how the farm business is run?

Yes

No



B4. Which ones ?

B5. During the last year, have you or the farm owner made any significant change in terms of animal health practices?

Yes

No

B6. Which ones ?

B7. This last year...

Yes Uncertain No

I worked more than usual

I/the farm have reduced staff hours

I/the farm have experienced staff shortages

I/the farm have experienced cash flow problems

I/the farm have delayed decision to make investments (e.g. buildings, machinery...)

Your clients changed their requirements (e.g. supermarkets increased or decreased their buyings)



B8. Regarding supplies ...

	Yes	Uncertain	No
I have been able to get animal feed as usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have been able to access to veterinary medicines as usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have been able to access to alternative medicines as usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have been able to access to hygiene products as usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B9. Regarding services...

	Yes	Uncertain	No
I have been able to maintain contact with other farmers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have been able to access advice on farm management as usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have been able to access to veterinary services as usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have been able to access to nutritionist services as usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Section C: Section 3 : Animal Health practices and antibiotic use

Our research focuses on animal health and the use of antibiotics in animal husbandry in 10 European and non-European countries. We would therefore like to ask you about the possible impacts of Covid-19 on these aspects.

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Thank you for completing this survey !

C1. How important are the following people to access knowledge and information on animal health management ?

1 not important at all and 5 very important

	1	2	3	4	5
Friends and colleagues	<input type="checkbox"/>				
Your private vet	<input type="checkbox"/>				
Government vets	<input type="checkbox"/>				
Consultants / Farm advisers	<input type="checkbox"/>				
Pharmaceutical representatives	<input type="checkbox"/>				
Farming Press	<input type="checkbox"/>				
Integrators and food industries	<input type="checkbox"/>				
Internet discussion groups and forums (eg WhatsApp, Facebook, Twitter)	<input type="checkbox"/>				
Training sessions with other farmers	<input type="checkbox"/>				



C2. During the last year :

Yes Uncertain No

I have paid more attention to animal nutrition

I have increased my biosecurity measures

I didn't notice any change regarding the health of my animals

I have lacked support and advice

I have taken decisions by myself due to unavailability of my vet and/or farm advisers

C3. More precisely regarding your vet :

Yes Uncertain No

My vet has been able to visit my farm as usual

I have talked to my vet on the phone more than usual

C4. More precisely regarding your farm adviser :

Yes Uncertain No

My farm adviser has been able to visit my farm as usual

I have talked to my farm adviser on the phone more than usual

C5. During the last year, did you change the way you use the following medicines?

Increase Same Decrease

Vaccines

Antibiotics

Anti-inflammatory

Complementary and alternative medicine

C6. How do you get to decide to use antibiotics ?

Yes Uncertain No

I have relied more than usual on my own expertise

I have used antibiotics more often without getting a visit from the vet



C7. In general :

	Yes	Uncertain	No
I feel more reassured when my vet prescribes antibiotics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I prefer to use antibiotics even if my vet prefers not to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

C8. How would you rate these different ways of using antibiotics, from irresponsible (1) to responsible (5)?

	1	2	3	4	5
When I treat a sick and suffering animal	<input type="checkbox"/>				
When I treat some sick animals and prevent the spread of infection to the rest of the herd	<input type="checkbox"/>				
When I prevent the emergence of new diseases	<input type="checkbox"/>				
When I can't wait for the vet to come	<input type="checkbox"/>				
When antibiotic use doesn't risk increasing harmful resistance for human health - antimicrobial resistance (also known as AMR)	<input type="checkbox"/>				

C9. Please indicate the extent to which you agree with the following statements about the use of antibiotics.

1 strongly disagree – 5 strongly agree

	1	2	3	4	5
I am worried about the effects of reducing the use of antibiotics on my animals	<input type="checkbox"/>				
I am worried about the effects of antimicrobial resistance on my business	<input type="checkbox"/>				
Antibiotics are an important tool to keep my animals healthy	<input type="checkbox"/>				
Antibiotics are not a problem for public health and the environment	<input type="checkbox"/>				
Using antibiotics is the most cost-effective method of animal health management	<input type="checkbox"/>				
There are too many rules and regulations to control the use of antibiotics	<input type="checkbox"/>				
I don't use too many antibiotics	<input type="checkbox"/>				
My vet cares about reducing the use of antibiotics	<input type="checkbox"/>				



C10. According to you, what are the best strategies to reduce antibiotic use ?

1 : strongly disagree ; 5 strongly agree

	1	2	3	4	5
Improving farm infrastructure (e.g. modernizing farm housing)	<input type="checkbox"/>				
Making changes in animal feeding	<input type="checkbox"/>				
Increasing vaccination programs	<input type="checkbox"/>				
Making changes in biosecurity measures	<input type="checkbox"/>				
Using alternative medicines	<input type="checkbox"/>				
De-intensifying the farm (e.g. : smaller herds, longer production cycles, less confinement of animals, etc.)	<input type="checkbox"/>				
Economic incentives for vets (less margins on antibiotics, etc.)	<input type="checkbox"/>				
Economic incentives for farmers (better price for antibiotic-free products, etc.)	<input type="checkbox"/>				
Raise awareness of farmers about the risks of antimicrobials	<input type="checkbox"/>				
I don't consider that reducing antimicrobial use is a reasonable thing to do	<input type="checkbox"/>				

C11. Reducing antibiotics could have the following consequences for my farm

	1	2	3	4	5
My staff and I would have to work more	<input type="checkbox"/>				
My farm would be less productive	<input type="checkbox"/>				
My animals would get sick more often	<input type="checkbox"/>				
Animal welfare would be compromised	<input type="checkbox"/>				
It would help me and my advisors to put prevention and advice at the heart of our work	<input type="checkbox"/>				
It would make my business more secure and performant for the future	<input type="checkbox"/>				



C12. Reducing antibiotics could have the following consequences for the society

1 : strongly disagree ; 5 strongly agree

	1	2	3	4	5
It would give vets and farmers a better image in society	<input type="checkbox"/>				
It would reduce the influence of the pharma industry	<input type="checkbox"/>				
It makes farming systems more sustainable	<input type="checkbox"/>				
Consumer confidence in food products would be higher	<input type="checkbox"/>				
It prevents the spread of AMR in society	<input type="checkbox"/>				
It reduces environmental pollution	<input type="checkbox"/>				
Prevention is better than cure for animal health and welfare	<input type="checkbox"/>				

C13. Where are the solutions/levers for change?

1 is strongly disagree and 5 is strongly agree

	1	2	3	4	5
Regulation (legislation about use, sale, prescription,...)	<input type="checkbox"/>				
Subsidies/incentives (e.g. to upgrade buildings)	<input type="checkbox"/>				
Private standards (e.g. to increase prices of AM-free products)	<input type="checkbox"/>				
Better training and education of farmers	<input type="checkbox"/>				
Better training and education of vets	<input type="checkbox"/>				
Development of new antibiotics	<input type="checkbox"/>				
Better monitoring of prescription and sales	<input type="checkbox"/>				
New farming systems	<input type="checkbox"/>				
No additional measures are required	<input type="checkbox"/>				
There is no problem related to antimicrobial resistance	<input type="checkbox"/>				



C14. Whose responsibility is it to prevent increasing antimicrobial resistance in farmed animals?

Please indicate the extent to which you agree that responsibility rests with the following people (1 strongly disagree - 5 strongly agree).

	1	2	3	4	5
The farmers	<input type="checkbox"/>				
The veterinary profession	<input type="checkbox"/>				
The Government	<input type="checkbox"/>				
The food industry	<input type="checkbox"/>				
The consumers / the general public	<input type="checkbox"/>				
The EU	<input type="checkbox"/>				
International organization (WHO, WTO, OIE...)	<input type="checkbox"/>				

Section D: Section 4 : Personal data

D1. The purpose of my participation in this project has been explained to me and is clear. I have read and understood the information consent sheet above, and obtained answers to my question.

Yes

No

D2. My participation in this project is voluntary. I have had enough time to decide to take part in this and there is no explicit or implicit coercion whatsoever to participate. I understand that I will not be paid for my participation. I have the right not to answer any of the questions. If I feel uncomfortable in any way during the session, I have the right to decline to answer any question or to withdraw from the questionnaire

Yes

No



D3. I understand that any summary interview content, or direct quotations from the survey, that are made available through academic publication or other forms of dissemination will be anonymized so that I cannot be identified, and care will be taken to ensure that other information in the interview that could identify myself is not revealed. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity of individuals and institutions

Yes

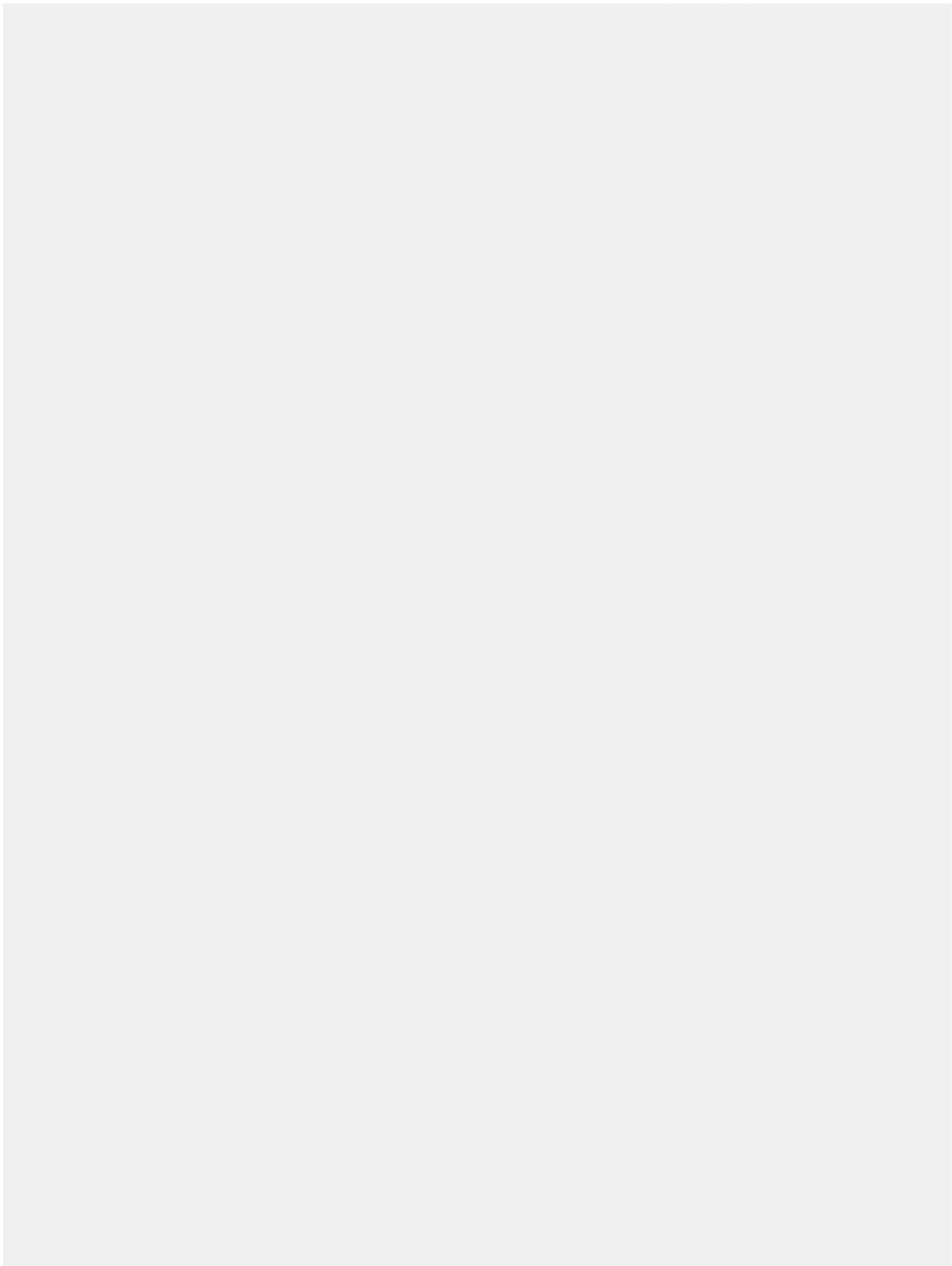
No

D4. I have read and understood the points and statements of this form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

Yes

No

Thank you !





Section A: Section 1: About You and the Vet Practice you work for

A1. In which country do you work ?

UK

France

Denmark

Netherlands

Belgium

Sweden

Italy

Switzerland

Spain

Germany

Vietnam

Other



A2. What is your nationality?

British

French

Danish

Dutch

Belgian

Swedish

Italian

Swiss

Spanish

German

Vietnamese

Other



A9. Your specialty or main production you work with :

Dairy

Cattle

Pig

Poultry: Broiler

Poultry: Layer

Sheep

Rabbit

A combination of those

A10. Number of large animal clients you personally follow :

More than 10

Less than 50

50-100

100-150

150-200

More than 200

A11. Number of staff in the practice you are working in :

Vets

Nurses and assistants

Admin staff



A12. What is important to you as a veterinarian?

1 strongly disagree; 5 strongly agree

	1	2	3	4	5
Caring for animals	<input type="checkbox"/>				
Ensuring animal health	<input type="checkbox"/>				
Caring for the environment	<input type="checkbox"/>				
To be respected in the community	<input type="checkbox"/>				
Ensuring product safety and quality	<input type="checkbox"/>				
Ensure that livestock are not a threat to public (human) health (e.g. zoonotic diseases)	<input type="checkbox"/>				
Supporting my clients / Developing a relationship of trust with my clients	<input type="checkbox"/>				
Making sure my business runs efficiently	<input type="checkbox"/>				
Use the most up-to-date processes and technologies	<input type="checkbox"/>				
Reducing the use of antibiotics in livestock production	<input type="checkbox"/>				

Section B: Section 2 : The Current situation regarding your work and business

Before we can adress the main topic of this survey, we would like to understand whether the current situation (Covid-19) impacts your professionnall activity

B1. How did you feel about your work this last year?

1 is strongly disagree ; 5 is strongly agree

	1	2	3	4	5
Because of the Covid-19 crisis, the stresses of my job were much harder to handle	<input type="checkbox"/>				
My work hasn't been impacted at all	<input type="checkbox"/>				
The Covid-19 crisis distracted me from taking pleasure in my work	<input type="checkbox"/>				
My business hasn't been impacted at all	<input type="checkbox"/>				

B2. In the last year, have you made any significant change in how you run your business or how you do your job?

Yes

No



B3. How ?

B4. In the last year, have you made any significant change in the way you work with your clients (e.g. farm visits, etc.)?

Yes

No

B5. Which ones ?

B6. This last year, you worked :

Less

As usual

More

B7. Why did you work more?

The practice I work in had staffing problems

I was requisitioned for other duties

I used more time for some background work

Other



B12. How did this change with the Covid-19 crisis? Your time spent on...

	Increase	Same	Decrease
Emergency	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Prevention or advice	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drug delivery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Office work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B13. Thinking about your experiences during the Covid-19 crisis, please indicate the extent to which you have ...

1 is not at all; 5 is very much

	1	2	3	4	5
Been proud of being a vet	<input type="checkbox"/>				
Been confident about the future of my business	<input type="checkbox"/>				
Been confident about the future of my clients' business	<input type="checkbox"/>				
Been worried about my own health and my family's	<input type="checkbox"/>				
Been worried about the health of my clients (farmers)	<input type="checkbox"/>				
Been worried about the health of the animals of my clients	<input type="checkbox"/>				
Felt under pressure to help farmers to produce food for the country	<input type="checkbox"/>				
Been proud of contributing to public health	<input type="checkbox"/>				
Not perceived any change in my work	<input type="checkbox"/>				
Not felt particularly concerned about the crisis	<input type="checkbox"/>				



Section C: Section 3 : Animal Health Practices and Antibiotic Use

Thank you for completing this survey !

C1. You use the following tools :

1 : rarely and 5 : very often

	1	2	3	4	5
Antibiotic susceptibility tests	<input type="checkbox"/>				
Diagnostic tests	<input type="checkbox"/>				
Autopsy	<input type="checkbox"/>				
Technical instruments (for measuring water quality, ventilation, humidity, etc.	<input type="checkbox"/>				

C2. How important are these different criteria when you decide to prescribe an antibiotic ?

1 : not important and 5 : very important

	1	2	3	4	5
Clinical effectiveness of the treatment	<input type="checkbox"/>				
Cost to the farmer	<input type="checkbox"/>				
Farmer request	<input type="checkbox"/>				
Convenience of the drug for the farmer (easy to use)	<input type="checkbox"/>				
My experience with using this antibiotic	<input type="checkbox"/>				
Urgency of the situation regarding the health of the animal/herd	<input type="checkbox"/>				
Profitability of this drug for me/my practice	<input type="checkbox"/>				
Risks for the environment and/or the (human) public health	<input type="checkbox"/>				



C3. Base your diagnosis on the following information :

Rank in order

Clinical observations

Microbiological data (antibiograms, biopsies, blood tests, etc.)

Epidemiological data (health conditions, etc.)

Technical and economic data on farm management

Farmer's descriptions of symptoms

C4. This last year, have you changed the way you use vaccines and antibiotics, or observed any change made by the farmers ?

	Increase	Same	Decrease
Vaccines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Antibiotics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Complementary and alternative medicines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Anti-inflammatory medicines	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

C5. Did you notice any change in the last year ?

	Yes	Uncertain	No
Veterinary fees became a bigger concern for my clients	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Medicine prices decreased	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My clients were more demanding in relation to antibiotics than usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There were more situations that required prescription of antibiotics than usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I had to prescribe without performing antibiotic susceptibility testing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I relied more than usual on the expertise of the farmer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I had to prescribe antibiotics without having been able to do a farm visit more often than usual	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There was no change in the way I prescribed antibiotics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



C6. How do you follow up on your clients?

I regularly call the farmers

I regularly do follow-up visits

The farmers call me if there are still problems

I rarely have the opportunity to follow up on other treatment

C7. What kind of pharmaceuticals do you use most ?

Rank in order

Antibiotics

Vaccines

Antiparasitic

Hormones

Anti-inflammatory medicines

C8.

C9. Which other products do you usually provide to your clients?

Never Sometimes Often

Hygiene products and disinfectants

Nutrition products

Alternative medicines (aromatherapy, homeopathy, etc.)

Other



C10. If other :

C11. How would you rate these different ways of using antibiotics, from irresponsible (1) to responsible (5)?

	1	2	3	4	5
When I treat a sick and suffering animal	<input type="checkbox"/>				
When I treat some sick animals and prevent the spread of infection to the rest of the herd	<input type="checkbox"/>				
When I prevent the emergence of new diseases	<input type="checkbox"/>				
When I can't wait for further analysis	<input type="checkbox"/>				
When I use an antibiotic in a way that doesn't favor harmful resistance for human health - antimicrobial resistance (also known as AMR)	<input type="checkbox"/>				

C12. To what extent do you agree with these strategies as a means to reduce antibiotic use?

1 : strongly disagree ; 5 : strongly agree

	1	2	3	4	5
Making changes in animal nutrition	<input type="checkbox"/>				
Increasing vaccination	<input type="checkbox"/>				
Making changes in biosecurity	<input type="checkbox"/>				
Using alternative medicines	<input type="checkbox"/>				
De-intensifying farms (smaller herds, longer production cycles, less confinement of animals, etc.)	<input type="checkbox"/>				
Economic incentives for vets (less margins on antibiotics, etc.)	<input type="checkbox"/>				
Economic incentives for farmers (better price for antibiotic-free products, etc.)	<input type="checkbox"/>				
Increasing awareness of farmers through training sessions	<input type="checkbox"/>				
It's not my job to encourage AMU reduction	<input type="checkbox"/>				



C13. Reducing antibiotics could have the following consequences :

1 : strongly disagree ; 5 strongly agree

	1	2	3	4	5
Animal health and welfare would be compromised	<input type="checkbox"/>				
The profitability of some farms (and therefore the job of some farmers) would be compromised	<input type="checkbox"/>				
The vet practice I work for would lose money and jobs would be in jeopardy	<input type="checkbox"/>				
I would have to work more	<input type="checkbox"/>				
Me and my clients would have to use other chemicals to compensate, which are more dangerous to human health or the environment	<input type="checkbox"/>				
It makes the relationship with my clients better	<input type="checkbox"/>				
It helps me to put prevention and advice at the heart of my work	<input type="checkbox"/>				

C14. Reducing antibiotics could have the following consequences for the society

1 : strongly disagree and 5 strongly agree

	1	2	3	4	5
It gives vets and farmers a better image in the society	<input type="checkbox"/>				
It helps farmers to become better farmers	<input type="checkbox"/>				
It reduces the influence of the pharma industry	<input type="checkbox"/>				
It helps the food system to become more sustainable	<input type="checkbox"/>				
It increases consumer confidence in food products	<input type="checkbox"/>				
It prevents the spread of AMR in the society	<input type="checkbox"/>				
It reduces environmental pollution	<input type="checkbox"/>				



C15. What are the solutions/levers for change?

1 is strongly disagree and 5 is strongly agree

	1	2	3	4	5
Regulation (legislation about use, sale, prescription,...)	<input type="checkbox"/>				
Subsidies/incentives (e.g. to upgrade the buildings)	<input type="checkbox"/>				
Private standards (e.g. increase prices of AM-free products)	<input type="checkbox"/>				
Better training and education of farmers	<input type="checkbox"/>				
Better training and education of vets	<input type="checkbox"/>				
Development of new antibiotics	<input type="checkbox"/>				
Better monitoring of prescription and sales	<input type="checkbox"/>				
New farming systems	<input type="checkbox"/>				
Redefinition of the role of veterinarians (advisor, health manager...)	<input type="checkbox"/>				
No additional measures are required	<input type="checkbox"/>				
There is no problem related to antimicrobial resistance	<input type="checkbox"/>				

C16. Whose responsibility is it to prevent increasing antimicrobial resistance in farmed animals?

Please indicate the extent to which you agree that responsibility lies with the following people (1 strongly disagree – 5 strongly agree)

	1	2	3	4	5
The farmers	<input type="checkbox"/>				
The veterinary profession	<input type="checkbox"/>				
The Government	<input type="checkbox"/>				
The food industry	<input type="checkbox"/>				
Consumers / the general public	<input type="checkbox"/>				
The EU	<input type="checkbox"/>				
International organization (WHO, WTO, OIE...)	<input type="checkbox"/>				
There is no problem related to antimicrobial resistance	<input type="checkbox"/>				



Section D: Section 4 : Personal data

D1. The purpose of my participation in this project has been explained to me and is clear. I have read and understood the information consent sheet above, and obtained answers to my question

Yes

No

D2. My participation in this project is voluntary. I have had enough time to decide to take part in this survey and there is no explicit or implicit coercion whatsoever to participate. I understand that I will not be paid for my participation. I have the right not to answer any of the questions. If I feel uncomfortable in any way during the session, I have the right to decline to answer any question or to withdraw from the session.

Yes

No

D3. I understand that any summary interview content, or direct quotations from the Questionnaire, that are made available through academic publication or other forms of dissemination will be anonymized so that I cannot be identified, and care will be taken to ensure that other information in the interview that could identify myself is not revealed. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity of individuals and institutions:

Yes

No

D4. I have read and understood the points and statements of this form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

Yes

No



Thank you for completing this survey !

We would like to find out more about your view of the impact of the Covid-19 crisis on your farm and animal health practices over the next 12 months.

Would you be willing for us to contact you about:

If you have answered yes to either of these questions, please provide us with your e-mail address and/or mobile phone number. Your contact details will be kept completely confidential. These will be used by our research team only for the specific purposes stated above. We will not share this information with any third parties.

E-mail address

Mobile phone number

Yes No Informal telephone interview

Follow-up online survey